

SSME FMEA/CIL
REDUNDANCY SCREEN

Component Group: Fuel Turbopumps
 CIL Item: B200-26
 Component: High Pressure Fuel Turbopump
 Part Number: RS007501
 Failure Mode: Structural failure.

Prepared: D. Early
 Approved: T. Nguyen
 Approval Date: 4/21/99
 Change #: 1
 Directive #: CCBD ME1-01-5206
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Phase	Failure / Effect Description	Criticality Hazard Reference
PSMCD 4.1	Immediate loss of turbopump output. External damage to engine from hydrogen fire or explosion and aft compartment overpressurization. Loss of vehicle. Redundancy Screens: SINGLE POINT FAILURE: N/A	1 ME-D1S M, ME-D1A,C ME-D3P,D

SSME FMEA/CIL DESIGN

Component Group: Fuel Turbopumps
CIL Item: B200-26
Component: High Pressure Fuel Turbopump
Part Number: RS007601
Failure Mode: Structural failure.

Prepared: D. Early
Approved: T. Nguyen
Approval Date: 4/21/99
Change #: 1
Directive #: CCBO ME3-01-5206

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Design / Document Reference

FAILURE CAUSE: A: Failure of parent metal or welds in main housing, inlet housing, thrust bearing housing or thrust bearing cap.

THE TURBOPUMP MAIN HOUSING (1) IS COMPRISED OF 3 PRIMARY SECTIONS, THE PUMP SECTION, THE TURBINE SECTION, AND THE PUMP DISCHARGE VOLUTE SECTION. THE TURBOPUMP MAIN HOUSING IS A WELDMENT OF MACHINED INCONEL 718 FORGINGS (2) EXCEPT FOR THE VOLUTE BACK PLATE, WHICH IS AN INCONEL 718 INVESTMENT CASTING (2). INCONEL 718 WAS SELECTED FOR ITS STRENGTH, RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING, AND CRYOGENIC DUCTILITY. THE MATERIAL IS SOLUTION TREATED, AGE-HARDENED, AND ANNEALED TO IMPROVE MECHANICAL PROPERTIES. INCONEL 718 HOUSING SURFACES AND WELDS EXPOSED TO HIGH-PRESSURE HYDROGEN GAS USE COPPER PLATING AND INCOLOY 88 WELD OVERLAY, RESPECTIVELY, TO PROVIDE HYDROGEN ENVIRONMENT PROTECTION. THE PUMP SECTION IS A THIN SHELL OUTER BARREL STRUCTURE THAT HAS NO HIGH-PRESSURE SEALS. A SEPARATE INTERNAL DIFFUSER CROSS-OVER ASSEMBLY CARRIES THE HIGH PRESSURE LOADS AND LEAKAGE INTO THE MAIN HOUSING IS VENTED TO THE PUMP INLET. THE THIRD-STAGE DIFFUSER VANES ARE MACHINED INTO THE PUMP SECTION AT THE ENTRY OF THE DISCHARGE VOLUTE. THE PUMP DISCHARGE VOLUTE SECTION IS THE STRUCTURAL MEMBER THAT CARRIES THE HIGH-PRESSURE PUMP DISCHARGE PRESSURE LOAD. THE VOLUTE LINER SHEET METAL IS MANUFACTURED UTILIZING INCONEL 718 AND PROVIDES THE FLOW PASSAGES THAT ARE HYDRODYNAMICALLY SHAPED FOR CONSTANT ANGULAR MOMENTUM TO MINIMIZE DIFFUSION LOSSES. THE VOLUTE BACK PLATE PROVIDES THE STATIONARY MEMBER OF THE BALANCE PISTON. THE TURBINE SECTION CONSISTS OF THE TURBINE OUTER RING AND THE INNER RING. THE INNER RING IS INTEGRAL TO THE OUTER RING THROUGH 12 STRUTS. THERMALLY INDUCED LCF CRACKING OF THE OUTER RING (3-6) HAS OCCURRED. G-6 FLANGE CRACKS ARE MAPPED AND EVALUATED AT EACH TURBOPUMP OVERHAUL (3). THE CRACKING LENGTH IS CONTROLLED TO PRECLUDE THE CRACK FROM REACHING THE STATIC SEAL GROOVE AND REDUCING THE EFFECTIVENESS OF THE SEAL. CONTINUED USE WITH ALLOWABLE DISCREPANCIES RESULTING FROM OPERATION IS EVALUATED AND CONTROLLED PER THE REQUIREMENTS OF THE MAINTENANCE CONTROL DOCUMENT (4). THE TURBINE EXHAUST TURNAROUND DUCT, COOLANT LINER, AND STRUT CANS ARE MANUFACTURED UTILIZING HAYNES 188 SHEET METAL (2). HAYNES 188 WAS SELECTED FOR ITS STRENGTH AT ELEVATED TEMPERATURES AND ITS LOW-CYCLE FATIGUE LIFE PROPERTIES IN HIGH-PRESSURE HYDROGEN. THE TURBINE EXHAUST TURNAROUND DUCT HAS 12 STIFFENER VANES AT THE DISCHARGE OF THE SECOND-STAGE BLADES AND 12 POSTS LOCATED BETWEEN THE TURBINE DISCHARGE STRUTS, TO ADD RIGIDITY TO THE TURNAROUND DUCT SHEET METAL. TURBINE-END HOUSING COOLANT IS PROVIDED BY HYDROGEN FLOWING FROM THE BALANCE PISTON CAVITY BETWEEN THE COOLANT LINER AND THE TURBINE OUTER RING, INTO THE STRUTS, AND THEN THROUGH THE INNER RING. THE LIFT-OFF SEAL DRAIN LINE AND BALANCE CAVITY PRESSURE LINE ARE FABRICATED UTILIZING 321 CRFS TUBING (2). THIS MATERIAL WAS SELECTED FOR ITS CRYOGENIC MECHANICAL PROPERTIES, DUCTILITY, AND ITS INSENSITIVITY TO HYDROGEN ENVIRONMENT EMBRITTLEMENT. THE HOUSING IS PROOF PRESSURE TESTED TO VERIFY ITS STRUCTURED INTEGRITY (5).

THE PUMP INLET (6) IS A WELDMENT OF FORGED AND SHEET 5AL-2.5Sn (ELI) TITANIUM ALLOY. THE PUMP INLET RECEIVES LIQUID HYDROGEN FROM THE LPFTP DISCHARGE DUCT AND GUIDES THE FLOW INTO THE INLET OF THE FIRST-STAGE IMPELLER. BLEED HOLES IN THE INLET DOME PROVIDE OVERPRESSURE PROTECTION FOR THE INLET AND HOUSING (7) RESULTING FROM LEAKAGE PAST THE HOUSING AND DIFFUSER PISTON RING SEALS. THE INLET IS PILOTTED ON AND BOLTED TO THE MAIN HOUSING. THE INLET IS PROOF PRESSURE TESTED TO VERIFY ITS STRUCTURAL INTEGRITY. THE THRUST BEARING HOUSING (7) PILOTS ON AND IS BOLTED (8) TO THE PUMP INLET. THE THRUST BEARING CAP (9) IS BOLTED (10) TO AND PILOTTED BY THE THRUST BEARING HOUSING AND PROVIDES ACCESS FOR THRUST BEARING INSPECTION WITHOUT REMOVAL OF THE THRUST BEARING HOUSING. THE PUMP INLET AND THRUST BEARING CAP ARE MANUFACTURED UTILIZING 5AL-2.5Sn (ELI) TITANIUM ALLOY (2). THIS ALLOY WAS SELECTED FOR ITS LOW DENSITY, STRENGTH, TOUGHNESS, FATIGUE PROPERTIES AT CRYOGENIC TEMPERATURES, RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING, AND RESISTANCE TO HYDROGEN ENVIRONMENT EMBRITTLEMENT AT OPERATING TEMPERATURES (2). THE INLET AND CAP ARE ANNEALED. THE INLET IS STRESS RELIEVED AFTER WELDING. THRUST BEARING HOUSING IS MANUFACTURED UTILIZING A HASTELLOY B FORGING (2). HASTELLOY B WAS SELECTED FOR ITS STRENGTH, RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING, LOW THERMAL EXPANSION, AND INSENSITIVITY TO HYDROGEN ENVIRONMENT EMBRITTLEMENT AT OPERATING TEMPERATURES (2). THE MATERIAL IS ANNEALED TO IMPROVE MATERIAL PROPERTIES. THE MAIN HOUSING AND PUMP INLET HAVE BEEN DESIGN VERIFICATION TESTED FOR LOW CYCLE FATIGUE, PRIMARY STRESS SAFETY FACTORS, AND DEFLECTIONS (11).

(1) RS007577, RS007568; (2) RSS-4520-10; (3) RL00528; (4) RSS-8793; (5) RL00024; (6) RS007535, RS007512; (7) R0019204; (8) ND112-0001; (9) RS007540; (10) MS9575; (11) RSS-404-26, RSS-404-40

Component Group: Fuel Turbopumps
CIL Item: B200-25
Component: High Pressure Fuel Turbopump
Part Number: RS007501
Failure Mode: Structural failure.

Prepared: D. Early
Approved: T. Nguyen
Approval Date: 4/21/99
Change #: 1
Directive #: CGBD ME3-01-5206

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Design / Document Reference

FAILURE CAUSE: B: Diffuser cracking causing overpressurization of pump housing.

THE FLOW FROM THE FIRST-AND SECOND-STAGE IMPELLERS PASSES THROUGH TWO DIFFUSER (1) (2) STAGES, WHICH GUIDES THE FLUID FROM THE DISCHARGE OF ONE IMPELLER TO THE INLET OF THE NEXT. THE DIFFUSERS ARE MANUFACTURED UTILIZING ALUMINUM ALLOY TENS-53-T60 CASTINGS (3). THIS MATERIAL WAS SELECTED FOR ITS STRENGTH TO WEIGHT RATIO, RESISTANCE TO CORROSION AND STRESS CORROSION CRACKING. ITS STRENGTH IS NOT DEGRADED IN HYDROGEN ENVIRONMENT. THE MATERIAL IS SOLUTION TREATED, AGE-HARDENED, AND ANODIZED. THE DIFFUSERS SUPPORT THE FRONT (4) AND REAR LABYRINTH (5) SEALS AND THE INTERSTAGE SEALS (6). PISTON RINGS (7) ARE USED TO SEAL AT THE DIFFUSER PILOT DIAMETERS. LEAKAGE FLOW PAST THESE SEALS IS VENTED TO INLET PRESSURE TO REDUCE THE LOADS ON THE HOUSING CASING (8). THE FIRST-STAGE DIFFUSER IS PINNED TO THE SECOND-STAGE DIFFUSER, WHICH IN TURN IS INDEXED TO THE HOUSING. IRREGULARLY SPACED LUGS IN THE HOUSING ENGAGE SLOTS IN THE DIFFUSER AND PROVIDE FREEDOM FOR THE DIFFUSERS TO MOVE AXIALLY RELATIVE TO THE HOUSING, WHILE REACTING TO THE TORQUE LOADS. THE DIFFUSERS ARE POSITIONED AXIALLY RELATIVE TO THE INLET IMPELLERS AND EACH OTHER BY USE OF SHIMS (9). THE SECOND-STAGE IS RADIALLY PILOTTED BY A LIP ON THE HOUSING. THE FIRST-STAGE DIFFUSER IS RADIALLY PILOTTED BY A LIP ON THE INLET. A PRELOAD SPRING (10) BETWEEN THE SECOND-STAGE DIFFUSER AND THE HOUSING KEEPS THE DIFFUSER AND SHIM STACK TIGHT FOR HANDLING AND SHIPPING PURPOSES. IN OPERATION THE PRESSURE FORCES LOAD THE STACK AGAINST THE INLET. THE DIFFUSER IS PROOF PRESSURE TESTED TO VERIFY ITS STRUCTURAL INTEGRITY (11). DESIGN VERIFICATION TESTING DEMONSTRATED THE FACTOR OF SAFETY FOR BURST ON A SECOND-STAGE DIFFUSER (12). THE DIFFUSERS HAVE BEEN DESIGN VERIFICATION TESTED FOR STRESS SAFETY FACTOR, LOW CYCLE FATIGUE LIFE, AND DEFLECTIONS (12).

(1) RSC07527; (2) RS007532; (3) RSS-8580-10; (4) R0012199 R0012206; (5) RS007529; (6) RS007531; (7) RES1261, RES1167; (8) RS007577, RS007568; (9) RS007564, RS007546; (10) RS007507; (11) RL00023 (12) RSS-404-22

FAILURE CAUSE: ALL CAUSES

THE HIGH AND LOW CYCLE FATIGUE LIFE FOR PUMP INLET, THRUST BEARING HOUSING, THRUST BEARING CAP, THE FIRST-STAGE DIFFUSER AND THE SECOND-STAGE DIFFUSER MEET CEI REQUIREMENTS (1). THE MAIN HOUSING IS LOW AND HIGH CYCLE FATIGUE LIFE LIMITED BY MAJOR WAIVER (6). THE MINIMUM FACTORS OF SAFETY FOR THESE PARTS MEET CEI REQUIREMENTS (2). THE HARDWARE PARENT MATERIALS WERE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH SINCE THEY ARE NOT FRACTURE CRITICAL PARTS, EXCEPT FOR THE HOUSING ASSEMBLY WHICH WAS CLEARED BY CRITICAL INITIAL FLAW SIZE DETECTABILITY AND THE INLET ASSEMBLY WHICH WAS CLEARED BY RISK ASSESSMENT (3). THE FMEA/CIL WELDS ARE CLEARED FOR FRACTURE MECHANICS/INDE FLAW GROWTH BY THE WELD ASSESSMENT (4). TABLE B200 LISTS ALL FMEA/CIL WELDS AND IDENTIFIES THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE AND THOSE WELDS IN WHICH THE ROOT SIDE IS NOT ACCESSIBLE FOR INSPECTION. THOSE WELDS IN WHICH THE CRITICAL INITIAL FLAW SIZE IS NOT DETECTABLE ARE ACCEPTABLE FOR FLIGHT BY RISK ASSESSMENT (4). REUSE OF PARTS DURING OVERHAUL IS CONTROLLED BY THE REQUIREMENTS OF THE OVERHAUL SPECIFICATION (5).

(1) R: 00532, CP320R0003B; (2) RSS-8546-16, CP320R0003B; (3) NASA TASK 117; (4) RSS-8756; (5) RL00528, (6) DAR 1199 DAR 2513 DAR 2091

**SSME FMEA/CIL
INSPECTION AND TEST**

Component Group: Fuel Turbopumps
 CIL Item: B200-26
 Component: High Pressure Fuel Turbopump
 Part Number: RS007504
 Failure Mode: Structural failure.

Prepared: D. Early
 Approved: T. Nguyen
 Approval Date: 4/21/99
 Change #: 1
 Directive #: CCBD ME3-01-5206

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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	INLET ASSEMBLY		RS007535
	INLET ASSEMBLY		RS007512
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RS007535
			RS007512
		FORGING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RB0170-152
		THE INLET IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
			RA0115-116
			RL00314
	WELD INTEGRITY	ALL WELDS ARE INSPECTED TO DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011
			RA0607-094
			RA0115-116
			RA0115-006
			RA1115-001
			RA0115-127
	HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS AFTER WELDING.	RA0111-024
ASSEMBLY INTEGRITY	THE INLET PROOF PRESSURE TEST IS PERFORMED PER SPECIFICATION REQUIREMENTS.	RL00024	
HOUSING		RS007566	
MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS	RS007566	
		RB0170-153	
		RB0170-154	
	FORGING IS PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116	
		RA0115-012	
	HOUSING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS	RA0115-116	
WELD INTEGRITY	ALL WELDS ARE INSPECTED PER DRAWING AND SPECIFICATION REQUIREMENTS PER WELD CLASS INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, RADIOGRAPHIC, ULTRASONIC, AND FILLER MATERIAL, AS APPLICABLE.	RL10011	
		RA0607-094	
		RA0115-116	
		RA0115-006	
		RA1115-001	
		RA0115-127	
HEAT TREAT	HEAT TREAT IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA0611-020	
SURFACE FINISH	COPPER PLATING AND PLASMA SPRAYING IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RA1109-002	
		RA0109-018	
		RA0109-019	
ASSEMBLY INTEGRITY	THE HOUSING PROOF PRESSURE TEST IS PERFORMED PER SPECIFICATION REQUIREMENTS.	RL00143	
HOUSING, BEARING THRUST		R0019204	
MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER DRAWING REQUIREMENTS.	R0019204	

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Component Group: Fuel Turbopumps
 CIL Item: B200-26
 Component: High Pressure Fuel Turbopump
 Part Number: RS007501
 Failure Mode: Structural failure.

Prepared: D. Early
 Approved: T. Nguyen
 Approval Date: 4/21/98
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
A	MATERIAL INTEGRITY	FORGING IS PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116
		THE HOUSING IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-012
	COVER		RA0115-116
	MATERIAL INTEGRITY	MATERIAL INTEGRITY VERIFIED PER SPECIFICATION REQUIREMENTS	RS007540
		FORGING IS PENETRANT AND ULTRASONIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RB0170-079
		COVER IS PENETRANT INSPECTED PER SPECIFICATION REQUIREMENTS.	RA0115-116 RA0115-012 RA0115-116
B	DIFFUSER, ASSEMBLY FIRST INTERSTAGE		RS007527
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-099
		CASTING IS RADIOGRAPHIC INSPECTED PER SPECIFICATION REQUIREMENTS.	RL10003
		PROOF PRESSURE TEST IS PERFORMED PER SPECIFICATION REQUIREMENTS.	RL00023
		SURFACE IS PENETRANT INSPECTED AFTER PROOF PRESSURE TEST PER SPECIFICATION REQUIREMENTS.	RA0115-116
	HEAT TREAT	HEAT TREAT IS VERIFIED PER DRAWING REQUIREMENTS.	RS007532
	SURFACE FINISH	ANODIZED FINISH IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS.	RA1609-003 RS007527
	DIFFUSER ASSEMBLY		RS007532
	MATERIAL INTEGRITY	MATERIAL INTEGRITY IS VERIFIED PER SPECIFICATION REQUIREMENTS.	RB0170-099
		PROOF PRESSURE TEST IS PERFORMED PER SPECIFICATION REQUIREMENTS.	RL00023
		DIFFUSER ACCESSIBLE SURFACES ARE PENETRANT INSPECTED PRIOR TO AND FOLLOWING PROOF PRESSURE TEST PER SPECIFICATION REQUIREMENTS.	RA0115-116
		DIFFUSER HIDDEN SURFACES ARE PENETRANT INSPECTED PRIOR TO AND FOLLOWING PROOF PRESSURE TEST PER SPECIFICATION REQUIREMENTS	RA0115-116 RL00343
HEAT TREAT	HEAT TREAT IS INSPECTED PER DRAWING REQUIREMENTS	RS007532	
SURFACE FINISH	THE ANODIZED FINISH IS VERIFIED PER DRAWING AND SPECIFICATION REQUIREMENTS	RA1609-003 RS007532	
ALL CAUSES	HPFTP		RS007501
	CLEANLINESS OF COMPONENTS	COMPONENTS ARE VERIFIED CLEANED PER SPECIFICATION REQUIREMENTS	RL10001
	ASSEMBLY INTEGRITY	THE PUMP SUBASSEMBLIES ARE INSPECTED DURING OVERHAUL PER SPECIFICATION REQUIREMENTS. INSPECTIONS INCLUDE: VISUAL, DIMENSIONAL, PENETRANT, AND REPLACEMENT OF USAGE ITEMS AS APPLICABLE, PER OVERHAUL CLASSIFICATION.	RL00528 RA0115-116

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Component Group: Fuel Turbopumps
 CIL Item: B200-26
 Component: High Pressure Fuel Turbopump
 Part Number: R8007501
 Failure Mode: Structural failure.

Prepared: D. Early
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 Change #: 1
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Failure Causes	Significant Characteristics	Inspection(s) / Test(s)	Document Reference
ALL CAUSES	ASSEMBLY INTEGRITY	OPERATION/PERFORMANCE IS VERIFIED BY ENGINE HOT FIRE TESTING AND 2ND E&M TESTS ON INSPECTIONS. TORQUE CHECKS ARE PERFORMED PRIOR TO EACH FLIGHT SHAFT TRAVEL IS PERFORMED PRIOR TO EACH FLIGHT. A HELIUM SIGNATURE LEAK TEST IS PERFORMED PRIOR TO EACH FLIGHT DATA FROM PREVIOUS FLIGHT OR HOT FIRE IS REVIEWED FOR PROPER TURROPUMP OPERATION/PERFORMANCE. (LAST TEST)	RL00050-04 RL00056-06 RL00056-07 RL00461 OMRSD V41BS0.020 OMRSD 500000.950 MSFC PLN 1228

Failure History: Comprehensive failure history data is maintained in the Problem Reporting database (PRAMS/PRACA) Reference: NASA letter SA21/88/308 and Rockefdyne letter 88RC09761.
 Operational Use: Not Applicable.

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SSME FMEA/CIL
FIELD CONFIGURATION VARIANCES FROM CIL RATIONALE

Component Group: Fuel Turbopumps
 Item Name: High Pressure Fuel Turbopump
 Item Number: B200
 Part Number: RS007501

Prepared: D. Early
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 Change #: 2
 Directive #: CCBD ME3-01-5208

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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
1. B200-15 RS007502; CAUSE A, B200-24; RS007605; CAUSE A THE INNER AND OUTER BEARING RACES ARE EDDY CURRENT INSPECTED PER RL00743.	BEARING RACES RECEIVED FROM SUPPLIER SPLIT BALL BEARING INCORPORATED RECEIVED NO GENERAL EDDY CURRENT INSPECTION	GENERAL EDDY CURRENT INSPECTION OF RACES REPLACES TYPE IVC IN PENETRANT INSPECTION IN DETECTING SURFACE FLAWS USE AS IS RATIONALE: 1. RACES SUPPLIED BY SPLIT BALL BEARING INCORPORATED RECEIVED 10X VISUAL AND TYPE IVC PENETRANT INSPECTION INSTEAD OF GENERAL EDDY CURRENT INSPECTION. FLAW DETECTABILITY RELIABILITY LEVELS BETWEEN PENETRANT AND GENERAL EDDY CURRENT INSPECTIONS ARE 0.060 AND 0.057 RESPECTIVELY.	SEE DAR 2745 FOR VARIANT PART SERIAL NUMBERS.
2. B200-13 RS007527, RS007532, CAUSE A & B. B200-26; RS007532; CAUSE B. DIFFUSER HIDDEN SURFACES ARE PENETRANT INSPECTED PER RL00343.	SOME DIFFUSERS MAY NOT RECEIVE THE POST PROOF TEST HIDDEN SURFACE IIP PENETRANT INSPECTION	USE AS IS RATIONALE 1. IMPLEMENTATION OF HIDDEN SURFACE INSPECTION REQUIREMENT IS NOT A RESULT OF AN OBSERVED HARDWARE ANOMALY BUT AS A RESULT OF ROCKETDYNE'S STAND DOWN.	SEE DAR 2751 FOR VARIANT PART SERIAL NUMBERS
3 B200-14 CAUSE A, RS007568 B200-21 CAUSE B, RS007568 B200-26 CAUSE A, RS007568 WELD JOINTS RS007568 TABLE B200 HPFT FMEA/CIL WELD JOINTS RS007568 HOUSING CURRENT CONFIGURATION IS THE ONE(1) PIECE "113" CAP, USING FOUR (4) WELDS AND FOUR (4) WELD NUMBERS	SOME HOUSINGS (POSSIBLY TWO) MAY HAVE BEEN FABRICATED WITH THE TWO (2) PIECE "113" CAPS (THIS HAS AN EXTRA WELD: #13 AND THREE EXTRA WELD NUMBERS 13, 68 & 69)	TO REDUCE CONFUSION ON THE DRAWING AND ON THE MANUFACTURING FLOOR	SEE MCR 2524. SAME -113 DASH NUMBER.
4 B200-02; CAUSE A, RS007524 CAUSE B, RS007524; CAUSE C, RS007524	SOME TURBINE BEARING SUPPORTS (RS007524) ARE FABRICATED USING A WELDMENT OF HAYES 188 SHEET METAL INSTEAD OF THE EDM FORGING.	HIGH CYCLE FATIGUE INDUCED INLET SHEET METAL CRACKS DO OCCUR FROM THE OPERATIONAL ENVIRONMENT EXPERIENCED DURING ENGINE OPERATION. THE CRACKING IS CONTROLLED PER THE REQUIREMENTS OF THE SHEET METAL INSPECTION SPECIFICATION (RL00655) WHICH LIMITS THE CRACKING LENGTH, SPACING, AND SHAPE, TO PRECLUDE SHEET METAL PIECES FROM DISLODGING. THE CRITERIA IS BASED ON CRACK GROWTH RATES AND ENGINE TEST EXPERIENCE. ANY CRACKS, WHICH EXCEED THE SPECIFICATION LIMITS, ARE WELD REPAIRED (RF0001-007). THE TURBINE BEARING SUPPORT WITH WELDED SHEET METAL IS LIFE LIMITED BY MAJOR WAIVER DAR 2709.	RS007524-201 AND SUBS.

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Component Group: Fuel Turbopumps
 Item Name: High Pressure Fuel Turbopump
 Item Number: B200
 Part Number: RS007501

Prepared: D. Early
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 Change #: 2
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Base Line Rationale	Variance	Change Rationale	Variant Dash Number
5 B200-18 CAUSE A, B200-17 CAUSE A, B200-18 CAUSE A, B200-19 CAUSE A, B200-22; CAUSE A,B,C,E	SOME LIFT-OFF SEAL HOUSING DRAIN LINES ARE FABRICATED USING INTERSECTING LINE DRILLED HOLES THE HOLE THAT INTERSECTS THE OUTSIDE DIAMETER OF THE HOUSING FLANGE HAS A PLUG INSTALLED. THE PLUG IS THEN WELDED AT THE HOUSING OUTSIDE DIAMETER TO FORM A TIGHT GAS SEAL	LOW CYCLE FATIGUE CRACKING HAS BEEN OBSERVED IN THE PLUG WELD. CRACK INITIATION AND PROPAGATION OCCURS AT SHUTDOWN/COOLDOWN ALL UNITS RECEIVE A STANDARD POST FLIGHT INSPECTIONS BY LEAK CHECK. LEAK CHECK POST FLIGHT WILL DETECT A CRACK PRIOR TO REFLIGHT. POST LEAKAGE AT THE DRAIN LINE IS LIMITED TO 10 SCIM. ALL FLIGHT UNITS WILL CONTINUE TO RECEIVE A LEAK CHECK POST FLIGHT FOR THE DRAIN LINE PLUG WELD UNTIL THE ENTIRE FLEET IS RETROFIT WITH THE EDM DRAIN LINE CONFIGURATION	R0019230-071 AND SUBS.

**SSME FMEA/CIL
WELD JOINTS**

Component Group: Fuel Turbopumps
 CIL Item: B200
 Component: High Pressure Fuel Turbopump
 Part Number: RS007501

Prepared: D. Early
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
SHIELD	R0012171	1,24, 28-52	GTAW	II	X			
SHIELD	R0012171	26	GTAW	II				
LIFT-OFF SEAL	R0019230	1, 2	GTAW	II	X			
SHIELD	R0019788	25, 28	GTAW	II				
SHIELD	R0019788	27, 50	GTAW	II	X			
SHIELD	R0019788	51, 52	GTAW	I				
SHIELD	R0019788	53, 55	GTAW	II				
BELLOWS	RS007505	1-4	GTAW	I		X		
BELLOWS	RS007505	5, 6	EBW	I		X		
INLET	RS007512	4	GTAW	I		X		
INLET	RS007512	5-6	GTAW	I				
INLET	RS007512	7-10, 12, 13	GTAW	I				
INLET	RS007512	11	EBW	II				
INLET	RS007512	14, 15	GTAW	I				
INLET	RS007512	16	GTAW	I		X		
BEARING SUPPORT	RS007524	14	EBW	I				
BEARING SUPPORT	RS007524	18	EBW	I	X			
BEARING SUPPORT	RS007524	29, 30	GTAW	I	X	X		
BEARING SUPPORT	RS007524	118	GTAW	I	X			
BEARING SUPPORT	RS007524	119, 121	EBW	I				
BEARING SUPPORT	RS007524	120	GTAW	II	X			
BEARING SUPPORT	RS007524	229-241	GTAW	II	X			
HOUSING	RS007568	75, 223, 228, 230, 298	GTAW	I	X	X	X	
HOUSING	RS007568	74	GTAW	I				
HOUSING	RS007568	48	EBW	I	X	X	X	
HOUSING	RS007568	43	GTAW	I	X			
HOUSING	RS007568	51	GTAW	II	X	X		
HOUSING	RS007568	52	GTAW	II	X			
HOUSING	RS007568	53	EBW	I				

Component Group: Fuel Turbopumps
 CIL Item: B200
 Component: High Pressure Fuel Turbopump
 Part Number: RS007501

Prepared: D. Early
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 Approval Date: 4/21/99
 Change #: 2
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
HOUSING	RS007568	56	EBW	II	X			
HOUSING	RS007568	56	GTAW	II	X			
HOUSING	RS007568	57, 324, 325	GTAW	II				
HOUSING	RS007568	58	GTAW	II	X	X	X	
HOUSING	RS007568	59	EBW	I				
HOUSING	RS007568	74, 229, 297	GTAW	I	X	X	X	
HOUSING	RS007568	76, 77	GTAW	I		X		
HOUSING	RS007568	78-89	GTAW	II	X			
HOUSING	RS007568	90-101	GTAW	II	X			
HOUSING	RS007568	102	GTAW	I	X			
HOUSING	RS007568	139	GTAW	II	X			
HOUSING	RS007568	140	GTAW	II	X			
HOUSING	RS007568	150, 154	GTAW	II	X			
HOUSING	RS007568	174-185	GTAW	II	X			
HOUSING	RS007568	191, 192, 195, 196, 245, 455, 456	GTAW	II	X	X		
HOUSING	RS007568	193, 194, 197-202, 204-207	GTAW	II		X		
HOUSING	RS007568	203, 217, 218, 234, 236	GTAW	II	X	X		
HOUSING	RS007568	212, 213	GTAW	II				
HOUSING	RS007568	214, 215	GTAW	II	X			
HOUSING	RS007568	222, 239	GTAW	I		X		
HOUSING	RS007568	224, 225	GTAW	I		X	X	
HOUSING	RS007568	226, 227	GTAW	I		X		
HOUSING	RS007568	231, 232	GTAW	II	X	X		
HOUSING	RS007568	233	GTAW	II	X			
HOUSING	RS007568	237, 238	GTAW	II				
HOUSING	RS007568	246-248	GTAW	II				
HOUSING	RS007568	326-349	GTAW	II	X			
HOUSING	RS007568	374-397	GTAW	II	X			
HOUSING	RS007568	399	GTAW	I	X	X	X	

Component Group: Fuel Turbopumps
 CIL Item: B200
 Component: High Pressure Fuel Turbopump
 Part Number: RS007501

Prepared: D. Early
 Approved: T. Nguyen
 Approval Date: 4/21/99
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Component	Basic Part Number	Weld Number	Weld Type	Class	Root Side Not Access	Critical Initial Flaw Size Not Detectable		Comments
						HCF	LCF	
HOUSING	RS007568	401-424	GTAW	II	X			
HOUSING	RS007568	425-448	GTAW	II	X			
HOUSING	RS007568	450 (OPT)	GTAW	II				
HOUSING	RS007568	450 (OPT)	EBW	II	X			
HOUSING	RS007568	454	GTAW	II	X			
HOUSING	RS007568	537 (OPT)	GTAW	II				
ROTOR SEAL	RS007588	1	EBW	I				
SEA.	RS007592	25	EBW	II	X			